We claim:

1. A method for overlaying a second layer pattern on a substrate having a first layer pattern, comprising:

(a) providing a substrate having a first photoresist layer formed thereon and patterning said first photoresist layer by a patternwise exposure through a first layer mask comprised of an inner pattern area and an outer region, and a plurality of first reference marks formed within the inner pattern area and on the outer region;

(b) transferring the first layer pattern into said substrate and removing said first photoresist layer to form a first layer pattern in said substrate wherein the first layer pattern includes first reference marks each having a center point;

(c) forming a second photoresist layer on the first layer pattern and patternwise exposing said second photoresist layer through a second layer mask comprised of an inner pattern area, an outer region, and a plurality of second reference marks formed within the inner pattern area and on the outer region wherein each second reference mark is matched with a first reference mark at a similar location on the first layer mask, said second photoresist layer is developed to form a second layer pattern with second reference marks each having a center point;

(d) determining the offset values of the center points for each matched pair of first and second reference marks formed in the first layer pattern and in the second layer pattern;

(e) inputting the offset values into an error table and applying a correction algorithm to the data in the error table which calculates adjustments in the exposure

tool settings for subsequent exposures with the second layer mask of a second photoresist layer on a first layer pattern; and

(f) removing the second reference marks in the second layer pattern by exposing said second photoresist layer comprised of the second layer pattern with a third mask having clear regions that are located at the same locations as the second reference marks in the second layer mask and then developing said second photoresist layer.

2. The method of claim **1** wherein said first reference marks on the first layer mask and said second reference marks on the second layer mask are clear regions that are surrounded by chrome and the first and second layer masks are binary masks.

3. The method of claim **1** wherein said first reference marks on the first layer mask and said second reference marks on the second layer mask are comprised of chrome that is surrounded by clear regions and the first layer mask and second layer mask are binary masks.

4. The method of claim **1** wherein said first reference marks on the first layer mask and said second reference marks on the second layer mask are regions that transmit light which is 180^{O} out of phase with light that is transmitted through adjacent regions and the first layer mask and second layer mask are phase shifting masks.

5. The method of claim **1** wherein each of said first reference marks on the first layer mask and each of the second reference marks on the second layer mask are comprised of a first pair of parallel lines oriented along an x-axis and a second pair of parallel lines oriented along a y-axis that intersect with said first pair of lines to form a square shape and wherein said lines have a length and a width.

6. The method of claim **5** wherein a first reference mark on a first layer mask is comprised of lines having a width of about 8 microns and a length of about 80 microns.

7. The method of claim **5** wherein a second reference mark on a second layer mask is comprised of lines having a width of about 2 microns and a length of about 40 microns.

8. The method of claim **5** wherein said all of said first reference marks on the first layer mask have the same length and width and wherein all of the second reference marks on the second layer mask have the same length and width.

9. The method of claim **1** wherein said first photoresist and said second photoresist are positive tone photoresists.

10. The method of claim **1** wherein a scanning electron microscope with top-down viewing capability (CD-SEM) is used to measure the (x,y) coordinates for the center points of each first reference mark in the first layer pattern and each second reference mark in the second layer pattern.

11. The method of claim **1** wherein said correction algorithm is used to make adjustments in exposure tool settings in terms of field rotation, magnification, x and y stage scale, orthogonality, and offset translation.

12. The method of claim **1** wherein a clear region in said third mask is slightly larger than a second reference mark in said second layer mask and said exposure with the third mask does not expose any pattern features in said second photoresist layer.

13. The method of claim **1** wherein said third mask is a binary mask.

14. The method of claim **1** wherein the calculations made by said correction algorithm enable a better overlay of the second layer pattern on the first layer pattern in

subsequent exposures than a correction algorithm that does not include measurements of reference marks located within an inner pattern area.

15. The method of claim **1** wherein a second layer pattern is overlaid on a first layer pattern on a plurality of substrates and the first patternwise exposure and second patternwise exposure are performed on multiple exposure tools and wherein steps (a) – (f) are performed for each combination of exposure tool, first layer mask, and second layer mask.

16. The method of claim **1** wherein the plurality of first reference marks are formed in a "m" x "n" array on the first layer mask and the plurality of second reference marks are formed in a "m" x "n" array on the second layer mask and wherein said error table is comprised of "m" rows and "n" columns.

17. A method for determining mask to mask error for improving the overlay of a second layer pattern on a first layer pattern formed in a substrate, said first layer pattern is formed by exposing a first photoresist layer through a first layer mask and transferring the first layer pattern into a substrate and the second layer pattern is formed by exposing a second photoresist layer with a second layer mask, comprising:

(a) providing a first layer mask comprised of an inner pattern area, an outer region, and a plurality of first reference marks formed within the inner pattern area and on the outer region, said first reference marks each have a center point with (x,y) coordinates;

(b) providing a second layer mask comprised of an inner pattern area, an outer region, and a plurality of second reference marks each formed within the inner pattern area and on the outer region wherein each second reference mark is

matched with a first reference mark and has a center point with the same (x,y) coordinates as a matching first reference mark on the first layer mask;

(c) measuring the (x,y) coordinates for the center points of the first reference marks and second reference marks and determining the offset values in terms of x and y deviations for each matched pair of first and second reference marks; and

(d) inputting the offset values into an error table and applying a correction algorithm to the data in the error table which calculates adjustments in exposure tool settings that are subsequently used to expose a second layer pattern with the second layer mask on a first layer pattern in a substrate that has been formed with the first layer mask.

18. The method of claim **17** wherein said first reference marks on the first layer mask and said second reference marks on the second layer mask are clear regions that are surrounded by chrome and the first layer mask and second layer mask are binary masks.

19. The method of claim **17** wherein said first reference marks on the first layer mask and said second reference marks on the second layer mask are comprised of chrome that is surrounded by clear regions and the first layer mask and second layer masks are binary masks.

20. The method of claim **17** wherein said first reference marks on the first layer mask and said second reference marks on the second layer mask are regions that transmit light which is 180^{o} out of phase with light that is transmitted through adjacent regions and the first layer mask and second layer mask are phase shifting masks.

21. The method of claim **17** wherein each of said first reference marks on the first layer mask and second reference marks on the second layer mask is comprised of a first pair of parallel lines oriented along an x-axis and a second pair of parallel lines oriented along a y-axis that intersect with said first pair of parallel lines to form a square shape and wherein said first and second pair of parallel lines have a length and a width.

22. The method of claim **21** wherein a first reference mark on the first layer mask is comprised of parallel lines having a width of about 8 microns and a length of about 80 microns.

23. The method of claim **21** wherein a second reference mark on the second layer mask is comprised of parallel lines having a width of about 2 microns and a length of about 40 microns.

24. The method of claim **21** wherein said all of said first reference marks on the first layer mask have the same length and width and wherein all of the second reference marks on the second layer mask have the same length and width.

25. The method of claim **17** wherein a Leica LMS IPRO metrology tool or equivalent is used to measure the (x,y) coordinates for the center point of each first reference mark and each second reference mark.

26. The method of claim **17** wherein the plurality of first reference marks are formed in a "m" x "n" array on the first layer mask and the plurality of second reference marks are formed in a "m" x "n" array on the second layer mask and wherein said error table is comprised of "m" rows and "n" columns.

27. The method of claim **17** further comprised of removing the second reference marks on the second layer mask after the correction algorithm is applied by a process comprising:

coating said second layer mask with a third photoresist layer and using a pattern generator machine to expose portions of the third photoresist layer at regions corresponding to the (x,y) coordinates of the second reference marks on the second layer mask;

removing the exposed portions of said third photoresist layer;

performing a dry or wet etch to remove the second reference marks on the second layer mask; and

stripping the third photoresist layer.

28. The method of claim **17** further comprised of removing the first reference marks on the first layer mask after the correction algorithm is applied by a process comprising:

coating said first layer mask with a third photoresist layer and using a pattern generator machine to expose portions of the third photoresist layer at regions corresponding to the (x,y) coordinates of the first reference marks on the first layer mask;

removing the exposed portions of said third photoresist layer;

performing a dry or wet etch to remove the first reference marks on the first layer mask; and

stripping the third photoresist layer.

29. A mask set used for determining layer to layer overlay error when forming a second layer pattern in a photoresist layer on a substrate having a first layer pattern and

for removing unwanted portions of the second layer pattern in the photoresist layer, comprising:

(a) a first layer mask having an inner device pattern area and a plurality of first reference marks, a chrome forbidden area surrounding the inner device pattern area, and an outer region surrounding the chrome forbidden area wherein each of said first reference marks has a center point with (x,y) coordinates;

(b) a second layer mask having an inner device pattern area and a plurality of second reference marks, a chrome forbidden area surrounding the inner device pattern area, and an outer region surrounding the chrome forbidden area region wherein each second reference mark is matched with a first reference mark on the first layer mask and has a center point with the same (x,y) coordinates as a matching first reference mark on the first layer mask; and

(c) a third mask with clear regions having the same (x,y) coordinates as the second reference marks on the second layer mask.

30. The mask set of claim **29** wherein said first layer mask and said second layer mask are binary masks and the first reference marks on the first layer mask and the second reference marks on the second layer mask are comprised of chrome on a transparent substrate.

31. The mask set of claim **29** wherein said first layer mask and said second layer mask are binary masks and the first reference marks on the first layer mask and the second reference marks on the second layer mask are clear regions that are surrounded by chrome.

32. The mask set of claim **29** wherein said first layer mask and said second layer mask are attenuated phase shifting or alternating phase shifting masks and the first reference marks and the second reference marks are regions comprised of a material that transmits light that is 180^{O} out of phase with light transmitted through an adjacent region.

33. The mask set of claim **29** wherein each of said first reference marks and said second reference marks is comprised of a first pair of parallel lines oriented along an x-axis and a second pair of parallel lines oriented along a y-axis that intersect with said first pair of parallel lines to form a square shape and wherein said parallel lines have a length and a width.

34. The mask set of claim **33** wherein a first reference mark on the first layer mask is comprised of lines having a width of about 8 microns and a length of about 80 microns.

35. The mask set of claim **33** wherein a second reference mark is comprised of lines having a width of about 2 microns and a length of about 40 microns.

36. The mask set of claim **33** wherein said all of said first reference marks on the first layer mask have the same length and width and wherein all of the second reference marks on the second layer mask have the same length and width.

37. The mask set of claim **29** wherein a first reference mark and a second reference mark are located at least 2 microns from the nearest pattern feature on a first layer mask and on second layer mask, respectively.

38. The mask set of claim **29** wherein a clear region on the third mask is larger than a second reference mark and each clear region is matched with a second reference mark on the second layer mask.